

1. In a computer system for mirroring data, an improvement comprising at least two flexible mirroring characteristics from a group of such characteristics, the system not necessarily having every characteristic in the group, wherein the group consists of:

a serverless destination characteristic by which the system mirrors data to a remote mirroring unit without requiring the use of a remote server attached to the remote mirroring unit;

a non-invasive characteristic by which the system mirrors data from a host through a local mirroring unit toward a remote mirroring unit without requiring on the host any software that is designed specifically for remote data mirroring;

a disk emulation characteristic by which the system mirrors data from a host to a local mirroring unit through a standard storage subsystem bus;

a TCP journey line characteristic by which the system mirrors data from a host through a local mirroring unit which operates as a TCP client over a journey line to a remote mirroring unit which operates as a TCP server; and

a multiplicity characteristic by which the system provides at least one of many-to-one mirroring and one-to-many mirroring.

2. The improvement of claim 1, wherein the improvement comprises at least three flexible mirroring characteristics from the group.

3. A computer system comprising the improvement of claim 2 in combination with a local server linked by a local link to at least one local mirroring unit, which is linked in turn by a journey link to a remote mirroring unit.

4. The improvement of claim 1, wherein the improvement comprises at least four flexible mirroring characteristics from the group.

5. A computer system comprising the improvement of claim 4 in combination with a local server linked by a local link to at least one local mirroring unit, which is linked in turn by a journey link to a remote mirroring unit.

6. The improvement of claim 1, wherein the improvement comprises all flexible mirroring characteristics of the group.

7. The improvement of claim 1, wherein the improvement characteristics comprise the serverless destination characteristic.

8. The improvement of claim 7, wherein the improvement characteristics further comprise the disk emulation characteristic.

9. The improvement of claim 7, wherein the improvement characteristics further comprise the non-invasive characteristic.

10. The improvement of claim 1, wherein the improvement characteristics comprise the disk emulation characteristic.

11. The improvement of claim 10, wherein the standard storage subsystem bus includes a SCSI connection.

12. The improvement of claim 10, wherein the standard storage subsystem bus
5 includes a fibre channel connection.

13. The improvement of claim 10, wherein the standard storage subsystem bus includes a USB connection.

10 14. A computer system comprising the improvement of claim 10 in combination with a local server linked by a local link to at least one local mirroring unit, which is linked in turn by a journey link to a remote mirroring unit.

15 15. The improvement of claim 1, wherein the improvement characteristics comprise the TCP journey line characteristic.

16. The improvement of claim 15, wherein the improvement characteristics further comprise the serverless destination characteristic.

20 17. The improvement of claim 15, wherein the improvement characteristics further comprise the non-invasive characteristic.

18. The improvement of claim 15, wherein the improvement characteristics further comprise the disk emulation characteristic.

19. The improvement of claim 18, wherein the improvement characteristics further comprise the serverless destination characteristic.

5 20. A computer system comprising the improvement of claim 15 in combination with a local server linked by a local link to at least one local mirroring unit, which is linked in turn by a journey link to a remote mirroring unit.

10 21. The improvement of claim 1, wherein the improvement characteristics comprise the non-invasive characteristic.

22. The improvement of claim 21, wherein the improvement characteristics further comprise the disk emulation characteristic.

15 23. A computer system comprising the improvement of claim 21 in combination with a local server linked by a local link to at least one local mirroring unit, which is linked in turn by a journey link to a remote mirroring unit.

20 24. A computer system comprising the improvement of claim 1 in combination with a local server linked by a local link to at least one local mirroring unit.

25. The system of claim 24, wherein the system further comprises at least one remote mirroring unit.

26. The system of claim 25, wherein the system further comprises at least one remote server connected to the remote mirroring unit.

27. A data mirroring system which is characterized by at least a disk emulation flexible mirroring characteristic and a many-to-one multiplicity flexible mirroring characteristic, the system for mirroring data from primary network servers having nonvolatile data stores, over journey links, to a remote nonvolatile data storage area, wherein the system comprises:

a source including at least two primary network servers, each primary server being linked through a respective local link to a respective local mirroring unit for sending mirrored data from the primary server to the local mirroring unit, each of the local mirroring units having a spoof packet generator and a nonvolatile data buffer for mirrored data, the local link including a standard storage subsystem bus and the local mirroring unit emulating a disk subsystem in communications over that bus; and

a destination including a remote mirroring unit having a destination nonvolatile storage for mirrored data received from the local mirroring units over the journey links.

28. The data mirroring system of claim 27, wherein the destination nonvolatile storage comprises one disk partition for each primary network server, each disk partition holding mirrored data for the respective primary network server.

29. The data mirroring system of claim 27, wherein the destination nonvolatile storage comprises one external hard disk for each primary network server, each external hard disk holding mirrored data for the respective primary network server.

30. The data mirroring system of claim 29, wherein each external hard disk is bootable.

31. The data mirroring system of claim 27, wherein the destination nonvolatile storage comprises one RAID unit for each primary network server, each RAID unit holding mirrored data for the respective primary network server.

32. The data mirroring system of claim 31, wherein each RAID unit is hot-swappable.

33. The data mirroring system of claim 27, wherein the primary servers comprise a first primary server and a second primary server, and the first primary server has a different operating system than the second primary server.

34. The data mirroring system of claim 27, wherein the destination nonvolatile storage is sufficiently large to hold the combined current nonvolatile data of all of the primary servers.

35. The data mirroring system of claim 27, wherein the standard storage subsystem bus comprises a SCSI bus.

36. The data mirroring system of claim 27, wherein the standard storage subsystem bus comprises a fibre channel connection.

37. The data mirroring system of claim 27, wherein the standard storage subsystem bus comprises a Universal Serial Bus connection.

38. The data mirroring system of claim 27, wherein the journey link comprises an Ethernet connection.

39. The data mirroring system of claim 27, wherein the journey link comprises a TCP connection.

40. The data mirroring system of claim 27, wherein the destination does not include a server.

41. The data mirroring system of claim 27, wherein at least one of the primary network servers does not include software designed specifically for remote data mirroring.

42. The data mirroring system of claim 27, wherein the remote mirroring unit is physically separated from at least one of the primary servers by a distance of at least ten miles.

43. The data mirroring system of claim 42, wherein the remote mirroring unit is physically separated from at least one of the primary servers by a distance of at least one hundred miles.

44. The data mirroring system of claim 27, wherein at least two of the primary servers are physically separated from each other by a distance of at least ten miles.

45. The data mirroring system of claim 27, wherein at least two of the primary servers are physically separated from each other by a distance of at least one hundred miles.

5 46. A data mirroring system which is characterized by at least a disk emulation flexible mirroring characteristic and a journey line flexible mirroring characteristic, the system for mirroring data from a host having a nonvolatile data store, over at least one journey link, to at least one remote nonvolatile data storage area, wherein the system comprises:

10 a source including a host linked through at least one local link for sending mirrored data to at least one local mirroring unit, each local mirroring unit generating pre-acknowledgements indicating storage of mirrored data in a nonvolatile data buffer of the local mirroring unit, each local link including a standard storage subsystem bus and each local mirroring unit emulating a disk subsystem in communications over that bus; and

15 a destination including at least one remote mirroring unit having a destination nonvolatile storage for mirrored data received from a local mirroring unit over a journey link which operates with relatively low bandwidth and relatively high latency in comparison to a storage area network link.

20 47. The data mirroring system of claim 46, wherein the destination nonvolatile storage comprises an external hard disk for holding mirrored data for the host.

48. The data mirroring system of claim 47, wherein the external hard disk is bootable.

49. The data mirroring system of claim 46, wherein the destination nonvolatile storage comprises a RAID unit for holding mirrored data for the host.

50. The data mirroring system of claim 49, wherein the RAID unit is hot-swappable.

51. The data mirroring system of claim 49, wherein the RAID unit includes internal striping software.

52. The data mirroring system of claim 49, wherein the RAID unit includes a hardware controller for striping.

53. The data mirroring system of claim 46, wherein the destination nonvolatile storage is sufficiently large to hold the current nonvolatile data of the host.

54. The data mirroring system of claim 46, wherein the host does not include software designed specifically for remote data mirroring.

55. The data mirroring system of claim 46, wherein the host does not include software for buffering mirrored data.

56. The data mirroring system of claim 46, wherein the host does not include software for transmitting mirrored data over the journey link.

57. The data mirroring system of claim 46, wherein the standard storage subsystem bus comprises a SCSI bus.

58. The data mirroring system of claim 46, wherein the journey link comprises a
5 packet transmission connection.

59. The data mirroring system of claim 46, wherein the journey link comprises a data stream transmission connection.

60. The data mirroring system of claim 46, wherein the local mirroring unit emulates
a disk subsystem in a communication which requests that disk formatting be performed.

61. The data mirroring system of claim 46, wherein the local mirroring unit emulates
a disk subsystem in a communication which requests that disk partitioning be performed.

62. The data mirroring system of claim 46, wherein the local mirroring unit emulates
a disk subsystem in a communication which requests that a disk integrity check be performed.

63. The data mirroring system of claim 46, wherein the journey link comprises an
20 Ethernet connection.

64. The data mirroring system of claim 46, wherein the journey link comprises a TCP connection.

65. The data mirroring system of claim 64, wherein the standard storage subsystem bus comprises a SCSI bus.

66. The data mirroring system of claim 64, wherein the standard storage subsystem
5 bus comprises a fibre channel connection.

67. The data mirroring system of claim 64, wherein the standard storage subsystem bus comprises a Universal Serial Bus connection.

10 68. The data mirroring system of claim 46, wherein the destination does not include a server.

69. The data mirroring system of claim 46, wherein the remote mirroring unit is physically separated from the host by a distance of at least ten miles.

15 70. The data mirroring system of claim 69, wherein the remote mirroring unit is physically separated from the host by a distance of at least one hundred miles.

20 71. The data mirroring system of claim 46, wherein the source comprises at least two hosts linked to at least two respective local mirroring units, and the destination comprises at least two remote mirroring units, each having a destination nonvolatile storage for mirrored data received from a respective local mirroring unit over a respective journey link.

72. The data mirroring system of claim 71, wherein at least two of the hosts are physically separated from each other by a distance of at least ten miles.

73. The data mirroring system of claim 72, wherein at least two of the hosts are
5 physically separated from each other by a distance of at least one hundred miles.

74. The data mirroring system of claim 46, further comprising a means for reconstructing a disk volume as it existed at a specified previous time.

10 75. The data mirroring system of claim 46, further comprising a full local mirrored volume.

76. A data mirroring system comprising at least one host and a means for mirroring data, the means for mirroring data including at least one mirroring unit, the system being further
15 characterized by the presence of at least one flexible mirroring characteristic in the system.

77. The data mirroring system of claim 76, wherein the system is characterized by the presence of at least two flexible mirroring characteristics in the system.

20 78. The data mirroring system of claim 76, wherein the system comprises at least one local server and at least two mirroring units, and the system is characterized by the presence of at least three flexible mirroring characteristics in the system.

79. The data mirroring system of claim 76, wherein the system comprises at least one local server, at least one remote server, and at least two mirroring units, and the system is characterized by the presence of at least three flexible mirroring characteristics in the system.

5 80. The data mirroring system of claim 76, wherein the system comprises at least one local server and at least two mirroring units, and the system is characterized by the presence of at least four flexible mirroring characteristics in the system.

10 81. The data mirroring system of claim 76, wherein the host comprises a storage area network.

82. The data mirroring system of claim 76, wherein the host comprises a network attached storage subsystem.

15 83. The data mirroring system of claim 76, wherein the host comprises a computer which is not a server.

84. The data mirroring system of claim 76, wherein the system comprises a full local mirror.

20 85. The data mirroring system of claim 84, wherein the local mirroring unit does not generate pre-acknowledgments.

86. The data mirroring system of claim 84, wherein the full local mirror receives data by way of a data fork done below a disk emulation layer of at least one mirroring unit.

87. The data mirroring system of claim 76, wherein the system comprises a circular
5 buffer with head and tail pointers.

88. The data mirroring system of claim 76, wherein the system comprises a dual host connection between a remote mirroring unit, a remote server, and a remote disk subsystem.

89. A method for facilitating flexible data mirroring, the method comprising at least two steps from a group of installing steps, the method not necessarily including every step in the group of installing steps, wherein the group of installing steps consists of the following steps:

connecting a host to a local mirroring unit with a standard storage subsystem bus permitting the local mirroring unit to emulate a disk subsystem in communications over
15 that bus;

connecting a local mirroring unit to a journey link for transmission of data;

connecting a remote mirroring unit to a journey link for reception of data; and

testing at least one mirroring unit after at least partial completion of at least one of the aforesaid connecting steps.

90. The method of claim 89, wherein the method comprises at least three steps from the group of installing steps.

91. The method of claim 90, wherein the method comprises all steps from the group of installing steps.

92. The method of claim 89, wherein the method further comprises at least one step from a group of transmitting steps, the method not necessarily including every step in the group of transmitting steps, wherein the group of transmitting steps consists of the following steps:

transmitting data from a host to a local mirroring unit over a standard storage subsystem bus while the local mirroring unit emulates a disk subsystem; and

transmitting data from a local mirroring unit over a journey link to a remote mirroring unit.

93. The method of claim 92, wherein the step of transmitting data from a host to a local mirroring unit transmits data over a SCSI bus while the local mirroring unit emulates a SCSI disk subsystem.

94. The method of claim 92, wherein the step of transmitting data from a host to a local mirroring unit transmits data over a fibre channel bus while the local mirroring unit emulates a fibre channel disk subsystem.

95. The method of claim 92, wherein the step of transmitting data from a host to a local mirroring unit transmits data over a Universal Serial Bus while the local mirroring unit emulates a USB disk subsystem.

96. The method of claim 92, wherein the step of transmitting data from a local mirroring unit over a journey link to a remote mirroring unit comprises transmitting packets over the journey link.

5 97. The method of claim 96, wherein the step of transmitting data from a local mirroring unit over a journey link to a remote mirroring unit comprises transmitting Ethernet packets over the journey link.

10 98. The method of claim 96, wherein the step of transmitting data from a local mirroring unit over a journey link to a remote mirroring unit comprises transmitting packets over the journey link using the TCP protocol.

15 99. The method of claim 92, wherein the step of transmitting data from a local mirroring unit over a journey link to a remote mirroring unit comprises transmitting a data stream over the journey link.

100. The method of claim 92, wherein the step of transmitting data from a local mirroring unit over a journey link to a remote mirroring unit comprises transmitting data over the journey link to a serverless remote mirroring unit.

20 101. A configured computer program storage medium which contains software to perform method steps for flexible data mirroring, the method comprising at least two steps from a group of transmitting steps, the method not necessarily including every step in the group of transmitting steps, wherein the group of transmitting steps consists of the following steps:

transmitting data from a host to a local mirroring unit over a standard storage subsystem bus while the local mirroring unit emulates a disk subsystem;

transmitting data from a local mirroring unit over a journey link to a remote mirroring unit using at least one of Ethernet packets and TCP packets; and

5 transmitting data from a local mirroring unit over a journey link to a serverless remote mirroring unit.

102. The configured program storage medium of claim 101, wherein the method comprises every step in the group of transmitting steps.

103. The configured program storage medium of claim 101, wherein the method comprises transmitting data from a host to a local mirroring unit over a SCSI bus while the local mirroring unit emulates a SCSI disk subsystem.

15 104. The configured program storage medium of claim 101, wherein the method comprises transmitting TCP packets over a journey link to a remote mirroring unit.

20 105. The configured program storage medium of claim 104, wherein the method further comprises transmitting TCP packets over the journey link to the remote mirroring unit while no remote server is connected to the remote mirroring unit.

106. The configured program storage medium of claim 101, wherein the method comprises transmitting Ethernet packets over a journey link to a remote mirroring unit.

107. The configured program storage medium of claim 106, wherein the method further comprises transmitting Ethernet packets over the journey link to the remote mirroring unit while no remote server is connected to the remote mirroring unit.

5 108. The configured program storage medium of claim 101, wherein the method further comprises transmitting data from the remote mirroring unit over another journey link to another remote mirroring unit.

10 109. The configured program storage medium of claim 101, wherein the method further comprises performing a switchover from a normal mirroring state to a recovery state.